# A Continuous Respiratory Rate Monitor Intended for Low – Resource settings: A Novel Device Pilot Study

Amee Amin[1], MD, Prince Mtenthaonga[2,4], RN, MSc Ep, Joshua Coyle[3], BS, Rowland Mjumira[4],BME, Lucky Mangwiro[4], MSc, BSc, Dip, Maria Oden[3,5],PhD, Rebecca Richards-Kortum[3,5],PhD, Queen Dube[2], PhD, Kondwani Kawaza[2], MBBS, FC Paeds, Cert Neon, Monika Patil[1], MD

[1]Division of Neonatology, Department of Pediatrics, Baylor College of Medicine/Texas Children's Hospital,[2]Dept of Pediatrics & Child Health, Kamuzu University of Health Sciences, Blantyre, Malawi.,[3]Rice 360 Institute for Global Health Technologies, Rice University, [4]NEST 360, Kamuzu University of Health Sciences, [5]Department of Bioengineering, Rice University.
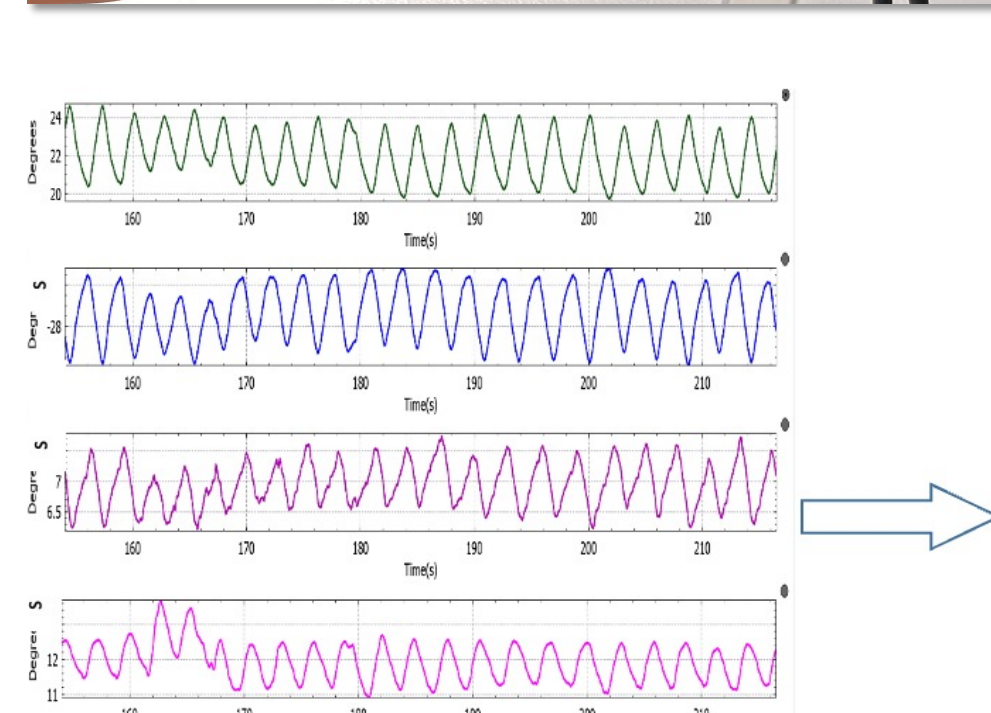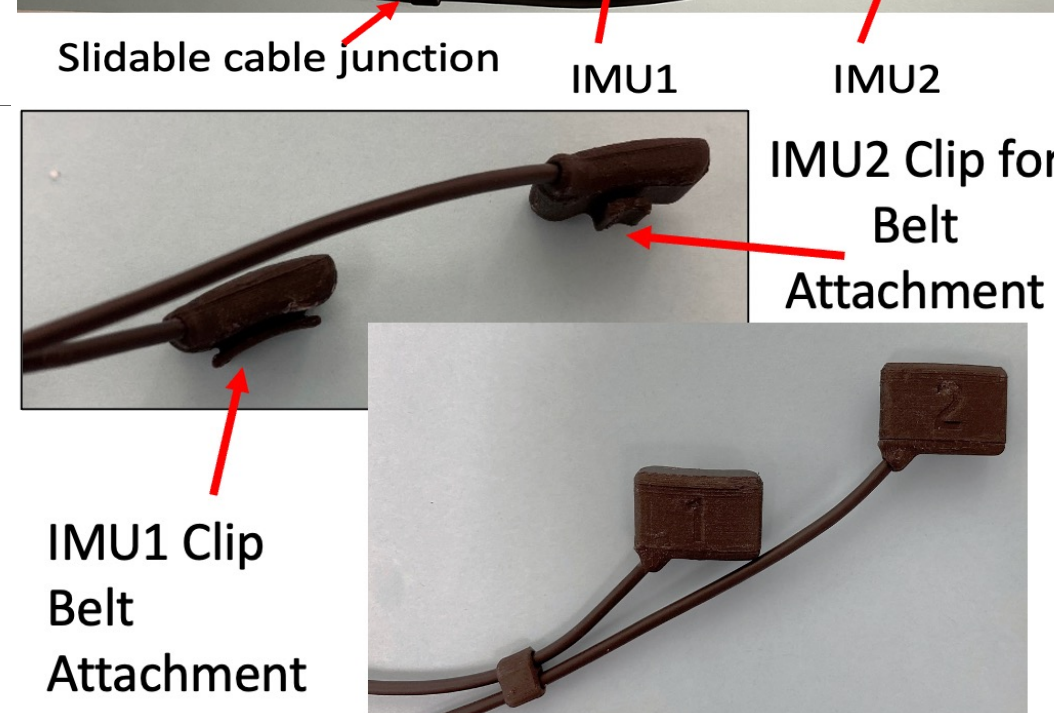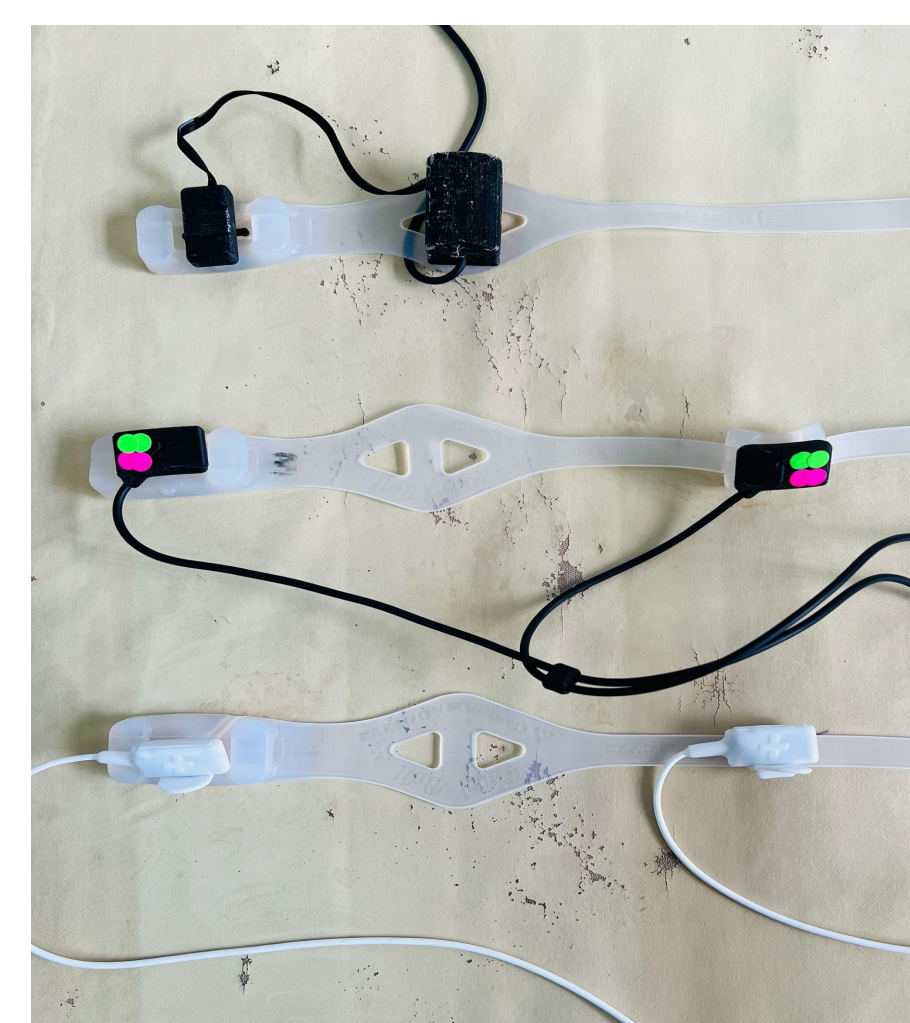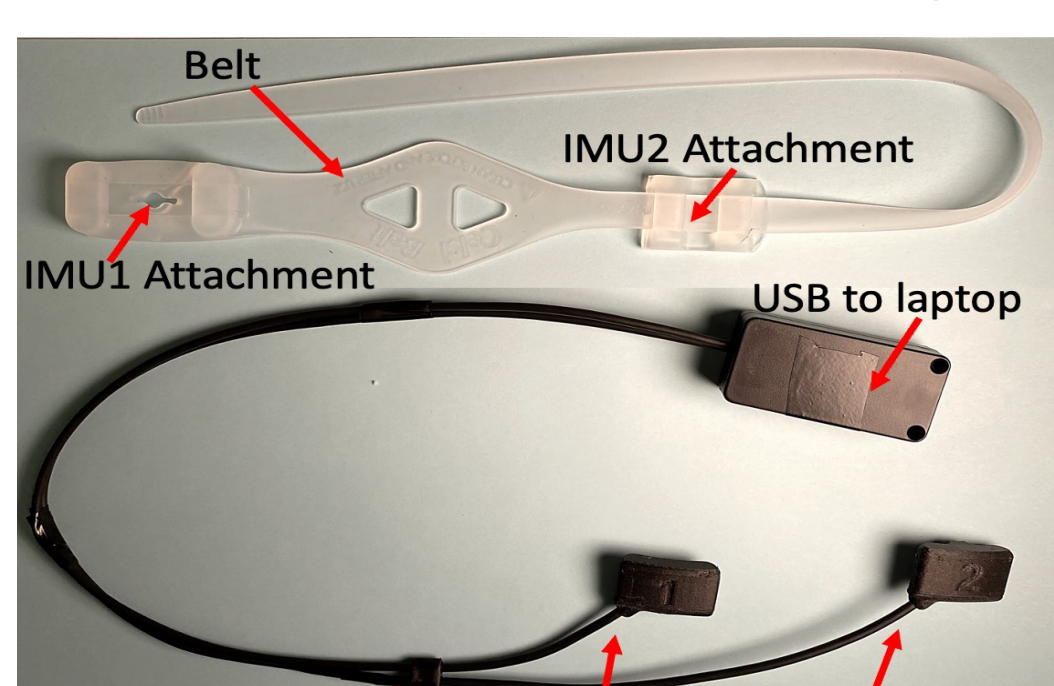
## BACKGROUND

- Neonatal deaths account for nearly 50% of all under age 5 mortalities.

- > 80% of these deaths in the world occur in Low and Middle-income countries (LMIC), largely from preventable causes.

- Continuous respiratory rate (RR) monitoring allows for rapid detection and treatment of serious and life-threatening complications

- In low – resource countries, patient monitors are often prohibitively expensive, and manual counting (as recommended by World Health Organization)  is impractical due to high patient – to – nurse ratios.
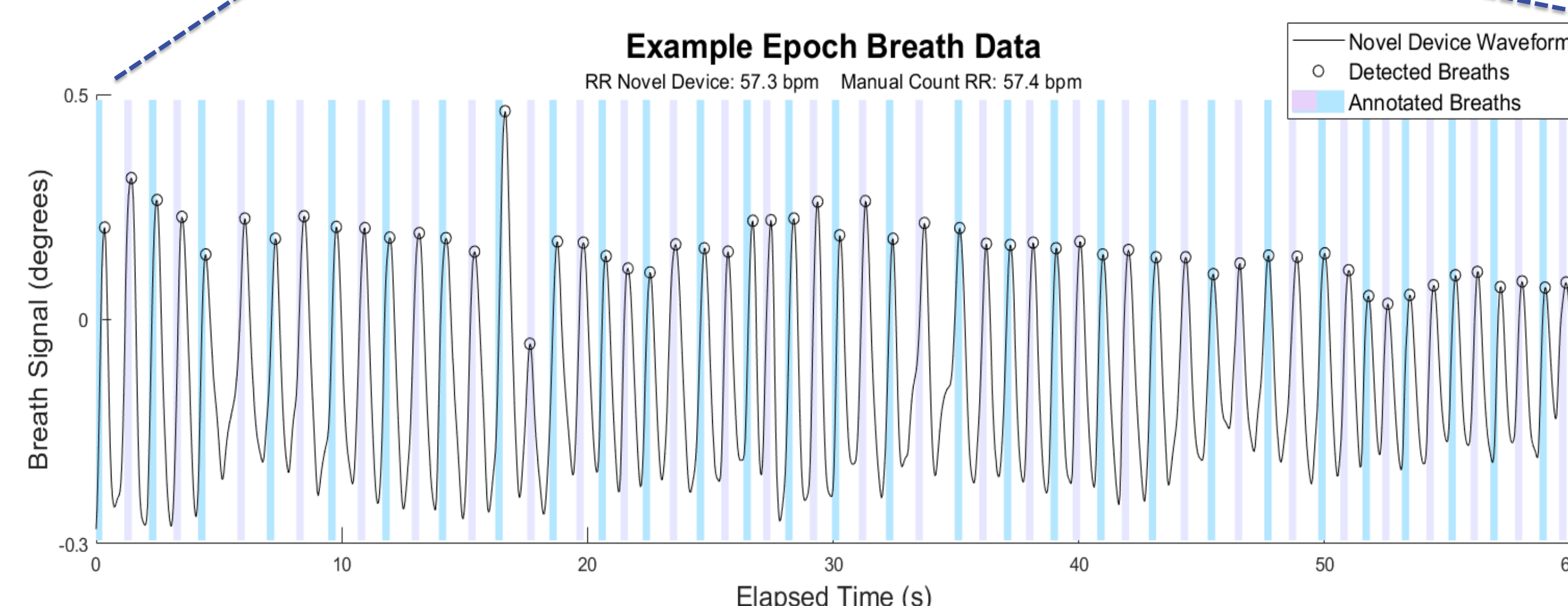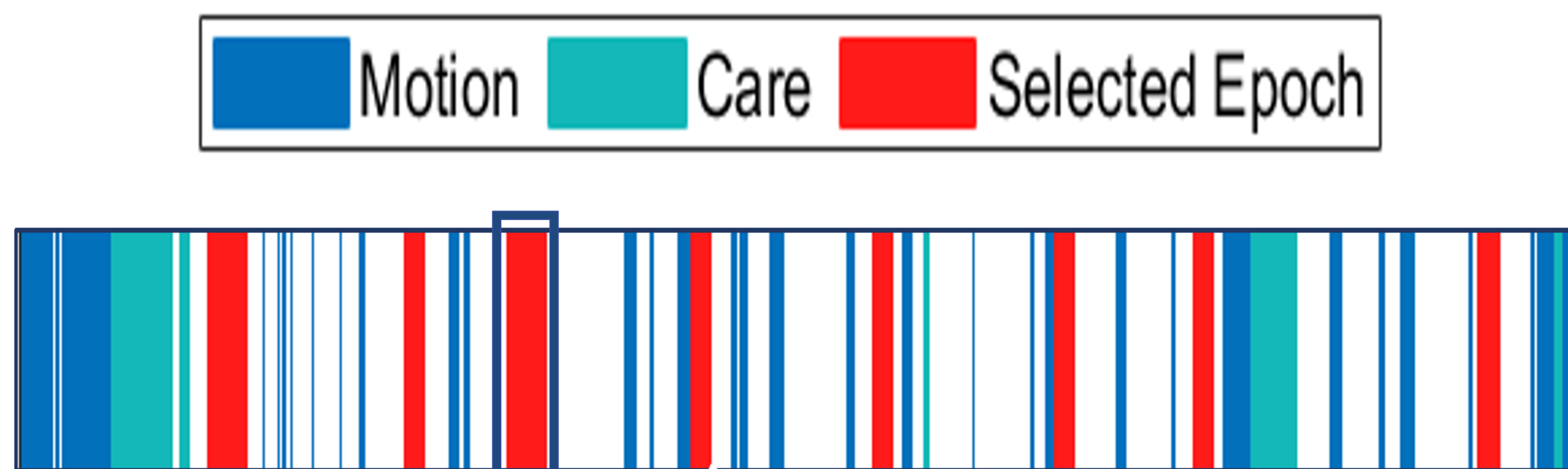
## OBJECTIVE

- To address this need, we are testing a novel low-cost Respiratory Rate (RR) monitor that identifies breaths by measuring  the displacement of an inertial measurement unit (IMU) sensor placed around the baby's abdomen.

- This pilot study aims to establish the accuracy of a novel device against reference visual counting.

## METHODS

- Preterm newborns at Texas Children's Hospital/ Queen Elizabeth Central Hospital were enrolled for continuous respiratory monitoring. Standard impedance pneumography monitoring (GE Dash 4000/ Phillips intellivue MP 30) and Webcam video monitoring (C925-E, Logitech) were concurrently used to monitor and count manual breaths.

- Inclusion Criteria:
  - Post Menstrual Age of ≥ 28wGA, ≥ 1000grams
  - Non-invasive respiratory support



Belt, IMU1 Attachment, IMU2 Attachment, USB to laptop, Slidable cable junction, IMU1, IMU2, IMU2 Clip for Belt Attachment, IMU1 Clip Belt Attachment

Derived Respiratory Waveform

## RESULTS
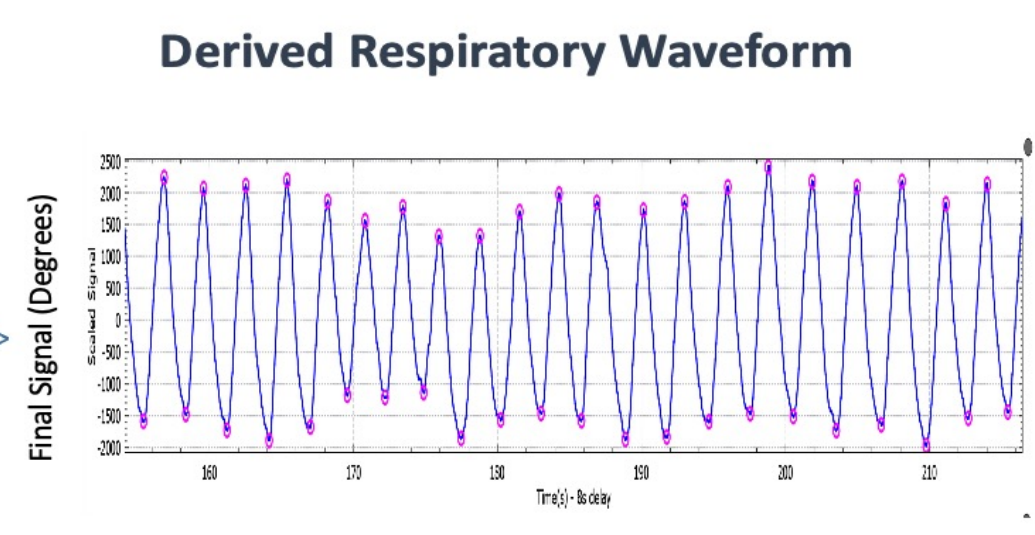
### EVENT ANNOTATION & EPOCH SELECTION THROUGH MONITORING TIME



Motion | Care | Selected Epoch

**Example Epoch Breath Data**
RR Novel Device: 57.3 bpm   Manual Count RR: 57.4 bpm

— Novel Device Waveform
○ Detected Breaths
▨ Annotated Breaths

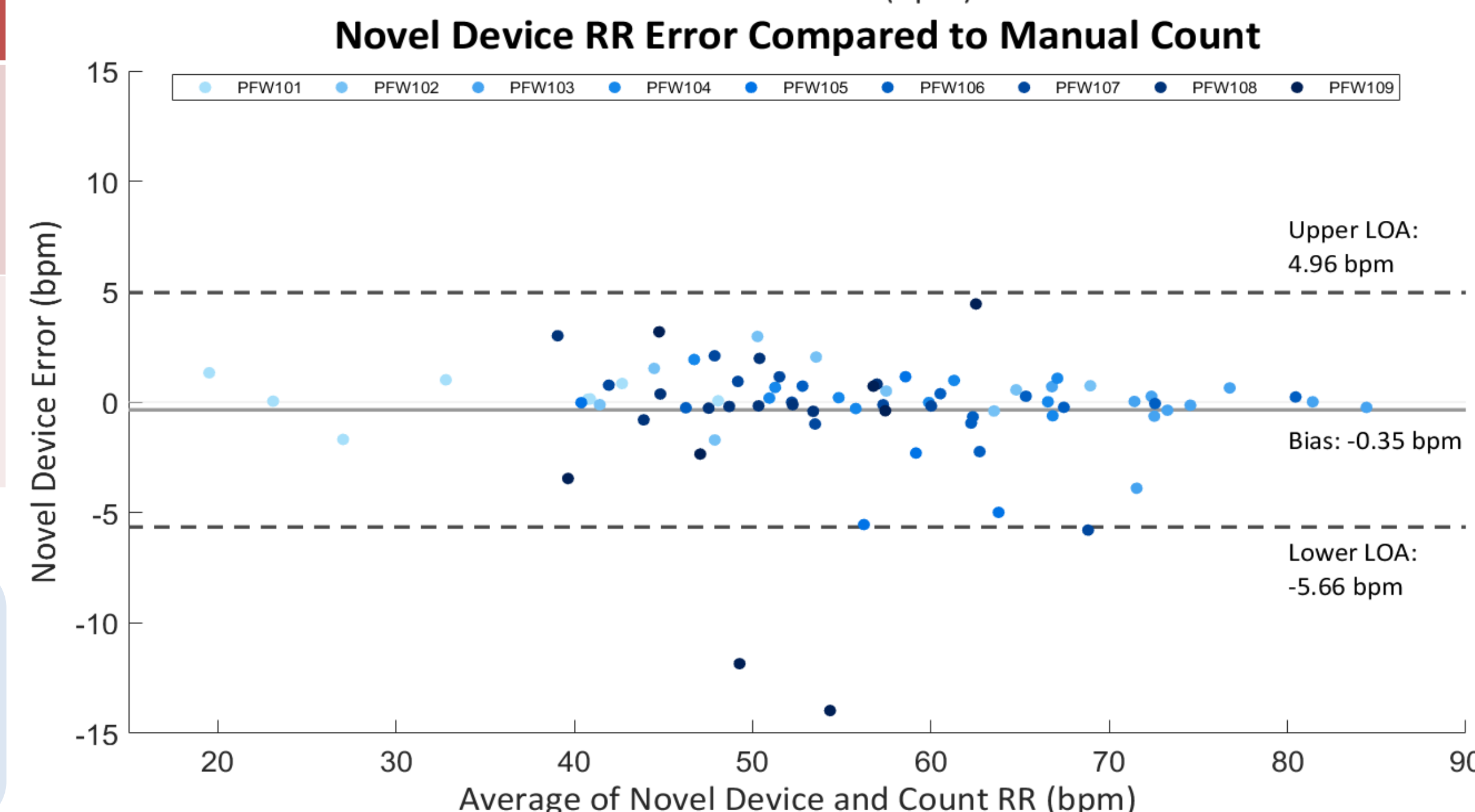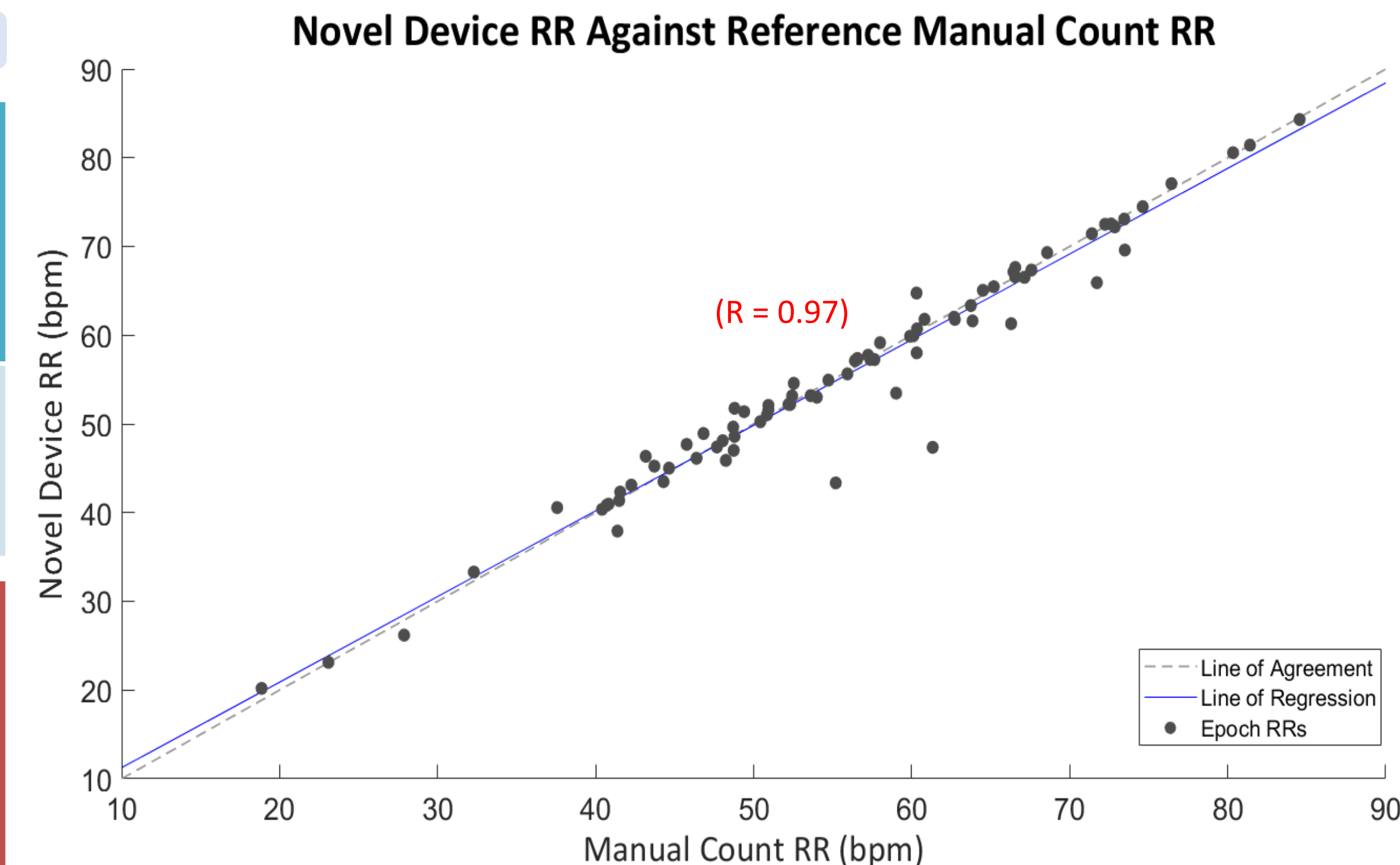Breath Signal (degrees) vs Elapsed Time (s)

**Epoch selection**
10 random 60 second segments from each participant's at-rest dataset.
From each epoch a RR was obtained from three modalities (Novel Device, Manual Breath Counting, Impedance Pneumography).
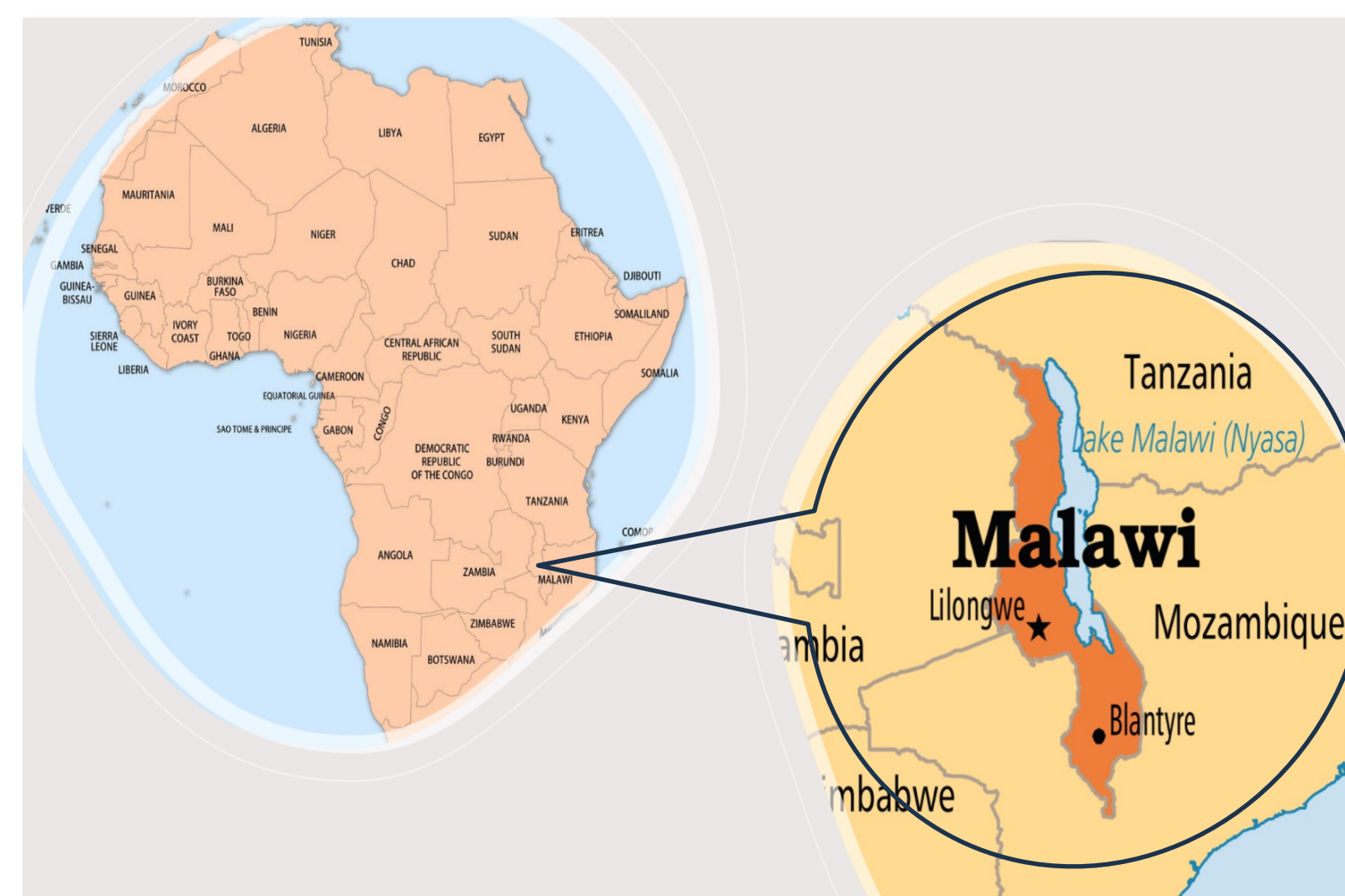
### TCH DEMOGRAPHIC DATA

| N | Total Monitoring Time (hours) | Male:Female |
|---|---|---|
| 20 | 42 | 45:55 |

| | Corrected Gestational Age (weeks) | Enrollment Weight (grams) |
|---|---|---|
| Mean | 31. 9 | 1459 |
| Range | (28.4 – 36.1) | (1035-1975) |

### Novel Device RR Against Reference Manual Count RR

(R = 0.97)

Novel Device RR (bpm) vs Manual Count RR (bpm)

--- Line of Agreement
— Line of Regression
● Epoch RRs

### Novel Device RR Error Compared to Manual Count

PFW101 PFW102 PFW103 PFW104 PFW105 PFW106 PFW107 PFW108 PFW109

Novel Device RR Error (bpm) vs Average of Novel Device and Count RR (bpm)

Upper LOA: 4.96 bpm
Bias: -0.35 bpm
Lower LOA: -5.66 bpm

## Malawi Cohort



Tanzania, Lake Malawi (Nyasa), **Malawi**, Lilongwe, Mozambique, Blantyre

**Patient Monitor Displaying the RR, waveforms, and alert signs for abnormal vitals.**

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RESPIRATORY RATE

### QECH DEMOGRAPHIC DATA

| N | Total Monitoring Time (hours) | Male : Female |
|---|---|---|
| 4 | 15 | 75:25 |

| | Corrected Gestational Age (weeks) | Enrollment Weight (grams) |
|---|---|---|
| Mean | 31.25 | 1420 |
| Range | (30 – 33) | (1300-1555) |

## CONCLUSION

- Our novel device shows a high degree of accuracy in detecting breaths compared to the gold standard methods in low resource countries (manual breath counting).

- This may offer a low-cost way to improve neonatal respiratory monitoring in low resource countries, potentially decreasing the burden on nurses and decreasing mortality and morbidity in sick and preterm newborns.

## REFERENCES

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Amee Amin, MD. Email: amee.amin@bcm.edu